Material Presented Herein Is Not Official Until Captured in TRA Deskbook

Technology Readiness Assessments: Milestone B Requirement for Technologies to be Demonstrated in a Relevant Environment

NDIA 10th Annual Systems Engineering Conference
October 22-25, 2007

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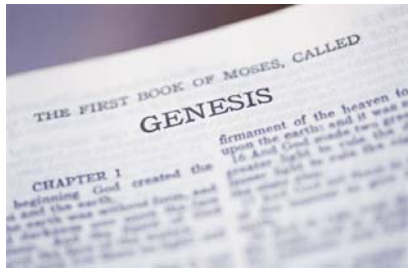
Outline

- **Introduction**
  - **What is a TRA**
  - **Why it is important**
- **Impact of 10 USC 2366a on TRA processes and practices**
  - **Technology maturation policy**
  - **Best practices for**
    - **Increasing TRA rigor**
    - **Focusing on technology maturity in source selection**
    - **Using the ADM to pursue technology maturation and insertion after Milestone B**
- **References and Resources**

How TRAs Got Started

- **"Program managers' ability to reject immature technologies is hampered by (1) untradable requirements that force acceptance of technologies despite their immaturity and (2) reliance on tools that fail to alert the managers of the high risks that would prompt such a rejection."** ***GAO/NSIAD-99-162***

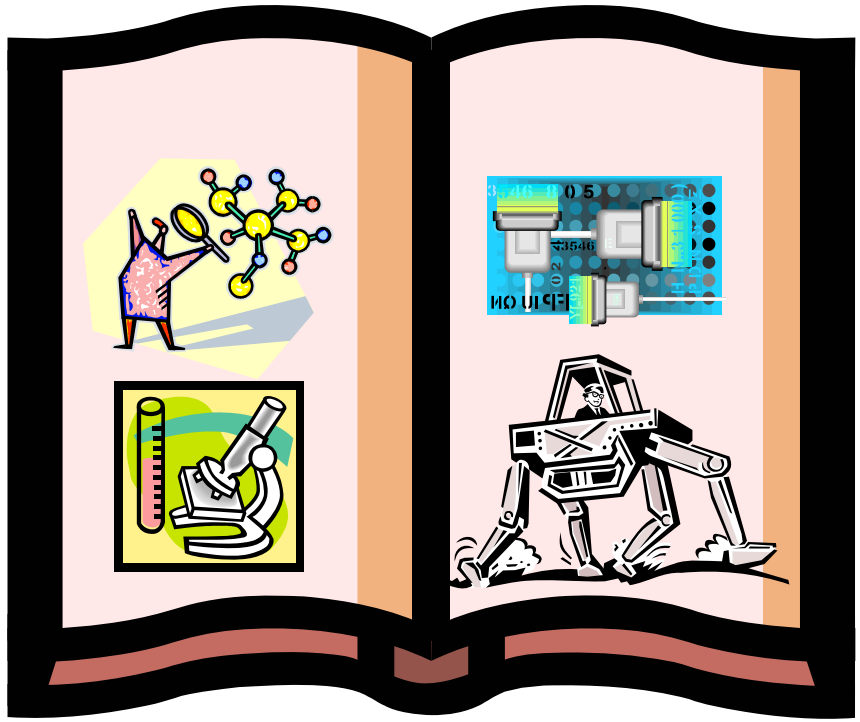


- **"Identify each case in which a major defense acquisition program entered system development and demonstration … into which key technology has been incorporated that does not meet the technology maturity requirement … and provide a justification for why such key technology was incorporated and identify any determination of technological maturity with which the Deputy Under Secretary of Defense for Science and Technology did not concur and explain how the issue has been resolved."** ***National Defense Authorization Act for Fiscal Year 2002***
- **"The management and mitigation of technology risk, which allows less costly and less time-consuming systems development, is a crucial part of overall program management and is especially relevant to meeting cost and schedule goals. Objective assessment of technology maturity and risk shall be a routine aspect of DoD acquisition."** ***DoDI 5000.2, paragraph 3.7.2.2***

Stop launching programs before technologies are mature

What is a TRA?

- **Systematic, metrics-based process that assesses the maturity of Critical Technology Elements (CTEs)**
  - **Uses Technology Readiness Levels (TRLs) as the metric**
- **Regulatory information requirement for *all* acquisition programs**
  - **Submitted to DUSD(S&T) for ACAT ID and IAM programs**



≠ Not a risk assessment

≠ Not a design review

≠ Does not address system integration

Critical Technology Element (CTE) Defined

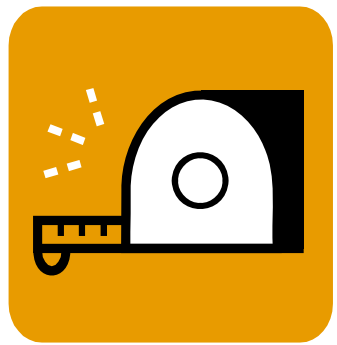
A technology element is "critical" if the system being acquired depends on this technology element to meet operational requirements with acceptable development cost and schedule and with acceptable production and operation costs *and* if the technology element or its application is either new or novel.

Said another way, an element that is new or novel or being used in a new or novel way is critical if it is necessary to achieve the successful development of a system, its acquisition or its operational utility.

CTEs may be hardware, software, manufacturing, or life cycle related at the subsystem or component level

TRL Overview

- **Measures technology maturity**
- **Indicates what has been accomplished in the development of a technology**
  - **Theory, laboratory, field**
  - **Relevant environment, operational environment**
  - **Subscale, full scale**
  - **Breadboard, brassboard, prototype**
  - **Reduced performance, full performance**



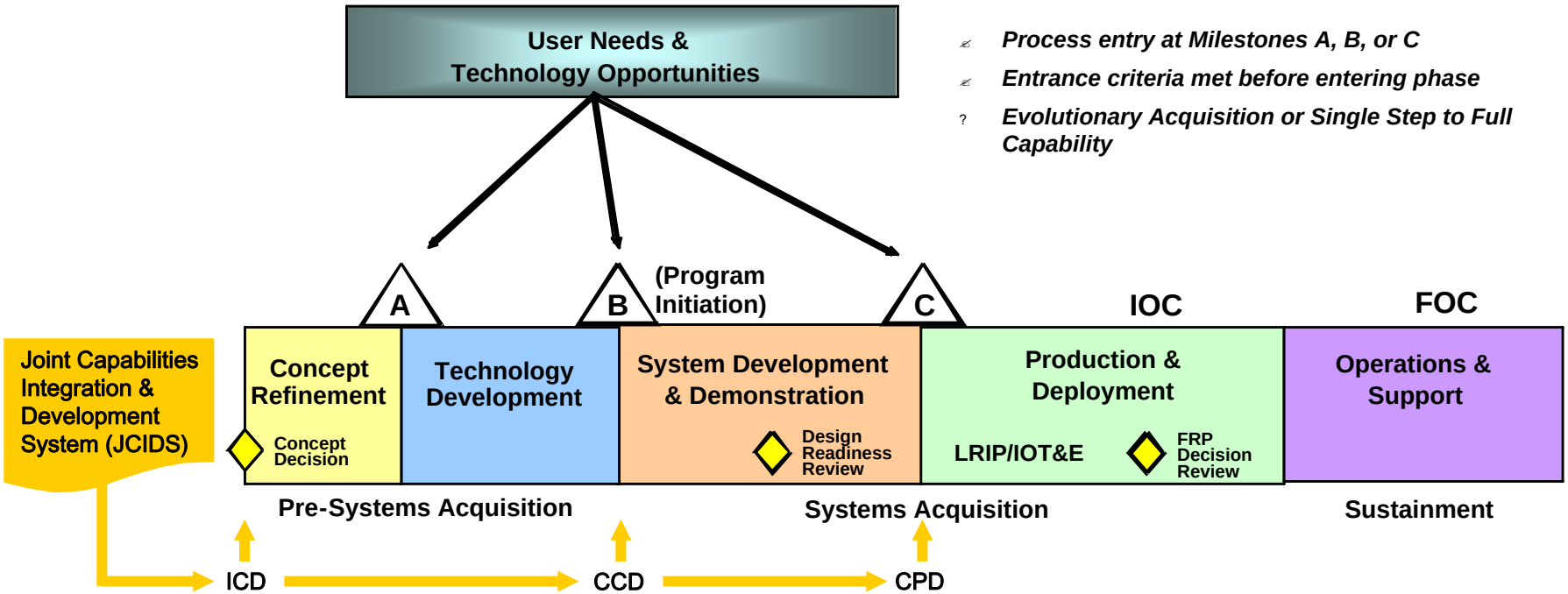
- **Does not indicate that the technology is right for the job or that application of the technology will result in successful development of the system**

Hardware and Manufacturing TRLs

Increasing maturity

1. Basic principles observed and reported
2. Technology concept and/or application formulated
3. Analytical and experimental critical function and/or characteristic proof of concept
4. Component and/or breadboard validation in a laboratory environment
5. Component and/or breadboard validation in a relevant environment
6. System/subsystem model or prototype demonstration in a relevant environment
7. System prototype demonstration in an operational environment
8. Actual system completed and qualified through test and demonstration
9. Actual system proven through successful mission operations

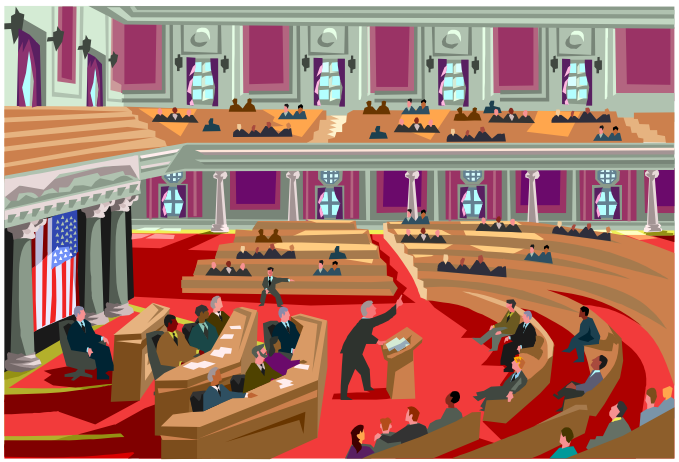
Overview of Technology Considerations During Systems Acquisition



TRAs required at MS B, MS C, and program initiation for ships (usually MS A).

Why is a TRA Important? (1 of 2)

- **The Milestone Decision Authority (MDA) uses the information to support a decision to initiate a program**
  - **Trying to apply immature technologies has led to technical, schedule, and cost problems during systems acquisition**
  - **TRA established as a control to ensure that critical technologies are mature, based on what has been accomplished**



- **Congressional interest**
  - **MDA must certify to Congress that the technology in programs has been demonstrated in a relevant environment at program initiation**
  - **MDA must justify any waivers for national security to Congress**

Quantifying the Effects of Immature Technologies (1 of 2)

According to a *2006* GAO review of 52 DoD programs:

- **Only 10% of programs began SDD with mature technology (TRL 7)**
  - **Programs that started with mature technologies averaged 4.8% development cost growth and a 1% acquisition unit cost growth**
  - **Programs that did not have mature technologies averaged 34.9% development cost growth and a 27% acquisition unit cost growth**
- **Only 23% of programs began SDD with DoD's standard for mature technology (TRL 6)**
  - **Programs that started with mature technologies averaged 18.8% development cost growth**
  - **Programs that started with mature technologies averaged 34.6% development cost growth**

Source: Defense Acquisitions: Assessments of Selected Major Weapon Programs, GAO-06-391, March 2006

Quantifying the Effects of Immature Technologies (2 of 2)

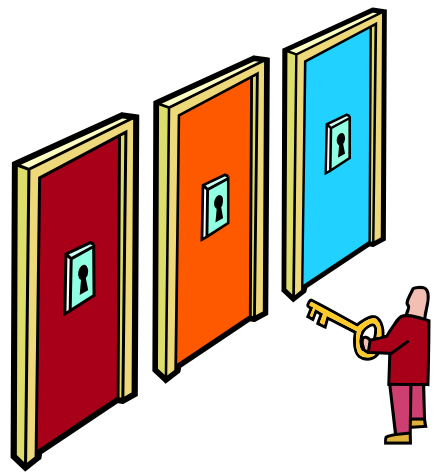
According to a *2007* GAO review of 33 DoD programs:

- **Only 16% of programs began SDD with mature technology (TRL 7)**
  - **Programs that started with mature technologies averaged 2.6% development cost growth, a 1% acquisition unit cost growth, and a 1 month schedule slippage**
  - **Programs that did not have mature technologies averaged 32.3% development cost growth, a 30% acquisition unit cost growth, and a 20 month schedule slippage**
- **Only 32% of programs began SDD with DoD's standard for mature technology (TRL 6)**
  - **Programs that started with mature technologies averaged 8.4% development cost growth**

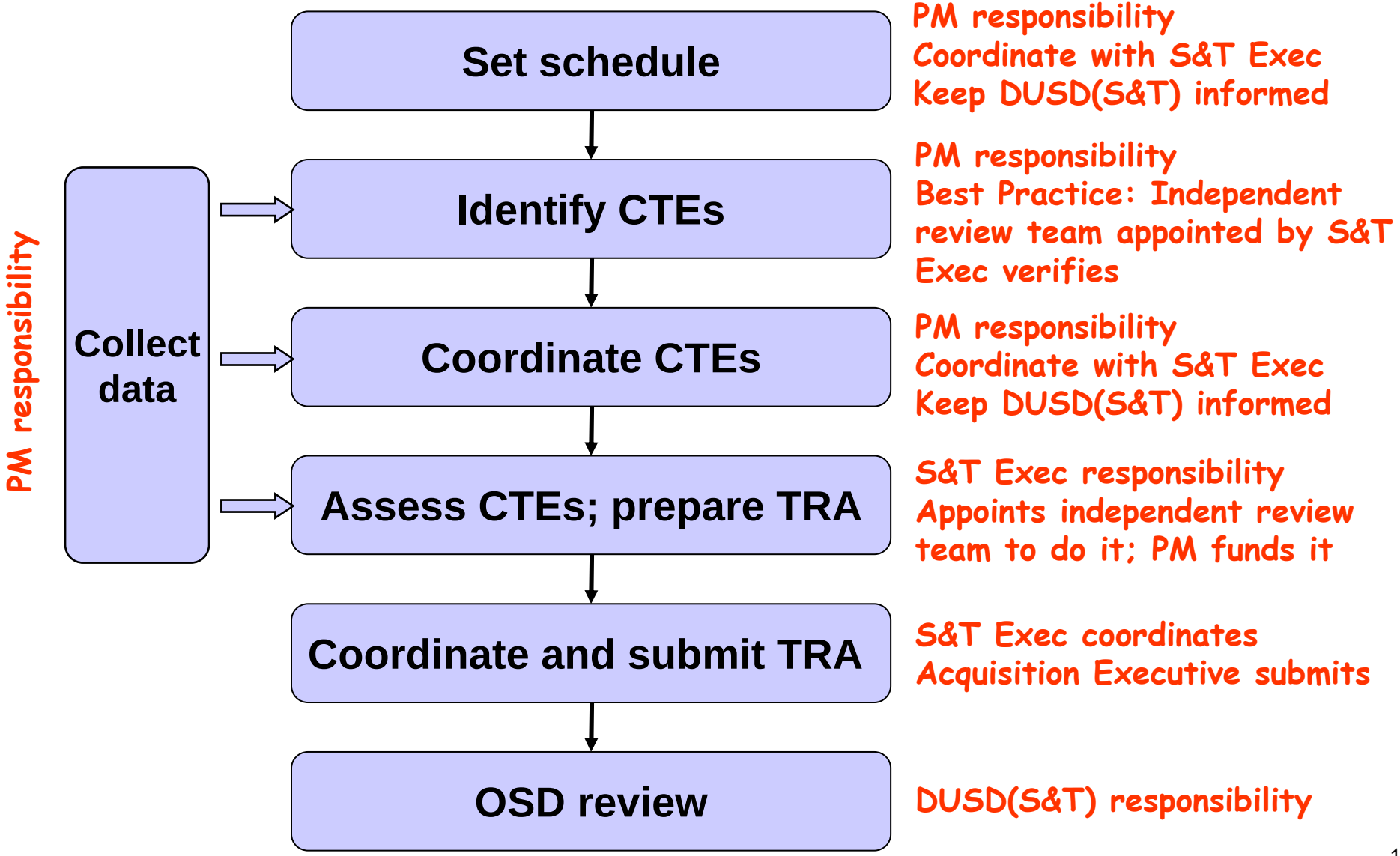
Source: Defense Acquisitions: Assessments of Selected Major Weapon Programs, GAO-07-406SP, March 2007

Why is a TRA Important? (2 of 2)

- **The PM uses the expertise of the assessment team and the rigor and discipline of the process to allow for:**
  - **Early, in depth review of the conceptual product baseline**
  - **Periodic in-depth reviews of maturation events documented as verification criteria in an associated CTE maturation plan**
  - **Highlighting *(and in some cases discovering)* critical technologies and other potential technology risk areas that require management attention (and possibly additional resources)**
- **The PM, PEO, and CAE use the results of the assessment to:**
  - **Optimize the acquisition strategy and thereby increase the probability of a successful outcome**
  - **Determine capabilities to be developed in the next increment**
  - **Focus technology investment**



Process Overview



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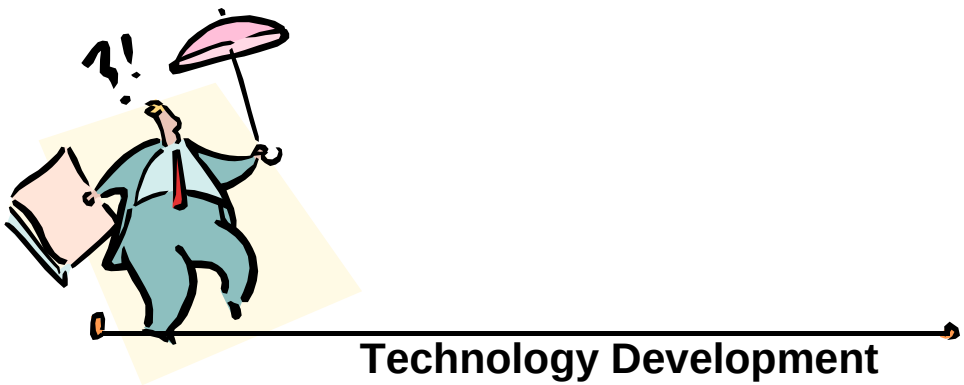
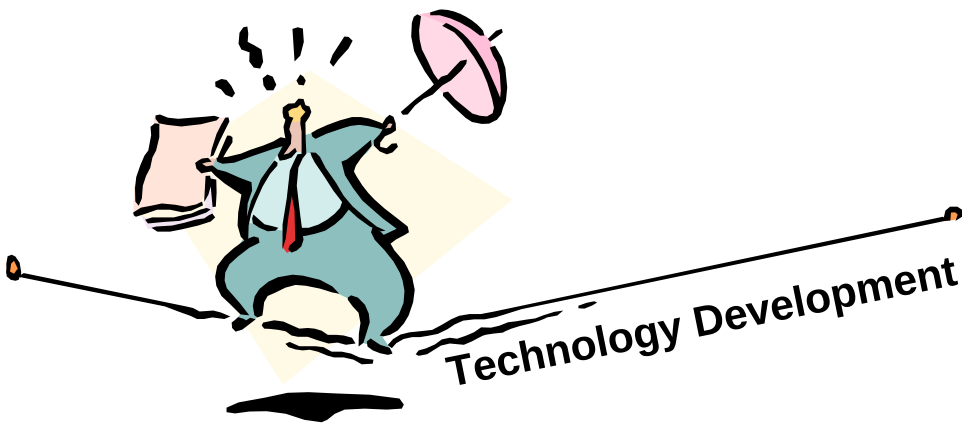
Technology Maturation Policy Leading to Milestone B is Unambiguous

"The project shall exit Technology Development when an affordable increment of militarily-useful capability has been identified, the technology for that increment has been demonstrated in a relevant environment, and a system can be developed for production within a short timeframe (normally less than five years); or when the MDA decides to terminate the effort. …. A Milestone B decision follows the completion of Technology Development." (DoDI 5000.2, paragraph 3.6.7)



Technology Maturation Policy Leading to Milestone B is Unambiguous (cont'd)

"The management and mitigation of technology risk, which allows less costly and less time-consuming systems development, is a crucial part of overall program management and is especially relevant to meeting cost and schedule goals.



Objective assessment of technology maturity and risk shall be a routine aspect of DoD acquisition. Technology developed in S&T or procured from industry or other sources shall have been demonstrated in a relevant environment or, preferably, in an operational environment to be considered mature enough to use for product development in systems integration. Technology readiness assessments, and where necessary, independent assessments, shall be conducted.

If technology is not mature, the DoD Component shall use alternative technology that is mature and that can meet the user's needs." (DoDI 5000.2, paragraph 3.7.2.2)

and • • •

• • • The Policy is Reflected as a Title 10 Requirement for Certification

10 USC §2366a states

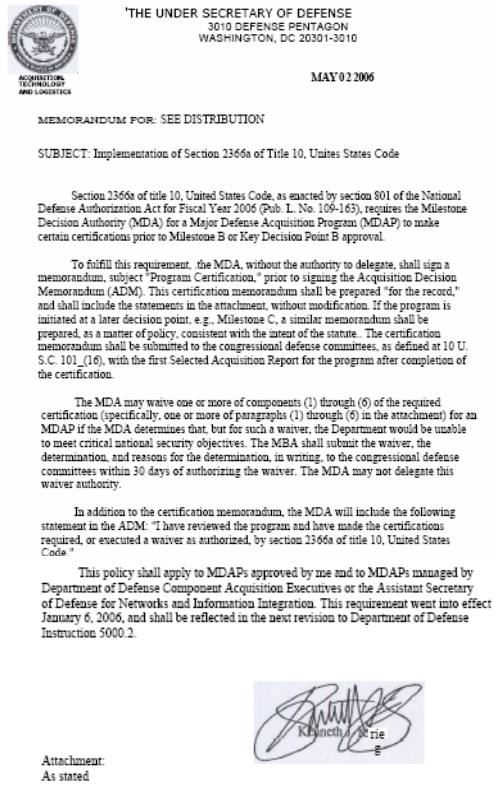
Major defense acquisition programs: certification required before Milestone B or Key Decision Point B approval:

(a) CERTIFICATION. A major defense acquisition program may not receive Milestone B approval, or Key Decision Point B approval in the case of a space program, until the milestone decision authority certifies that –

(2) the technology in the program has been demonstrated in a relevant environment;

. . .

(10) the program complies with all relevant policies, regulations and directives of the Department of Defense



'THE UNDER SECRETARY OF DEFENSE
3010 DEFENSE PENTAGON
WASHINGTON, DC 20301-3010

ACQUISITION, TECHNOLOGY AND LOGISTICS

MAY 02 2006

MEMORANDUM FOR: SEE DISTRIBUTION

SUBJECT: Implementation of Section 2366a of Title 10, Unites States Code

Section 2366a of title 10, United States Code, as enacted by section 801 of the National Defense Authorization Act for Fiscal Year 2006 (Pub. L. No. 109-163), requires the Milestone Decision Authority (MDA) for a Major Defense Acquisition Program (MDAP) to make certain certifications prior to Milestone B or Key Decision Point B approval.

To fulfill this requirement, the MDA, without the authority to delegate, shall sign a memorandum, subject "Program Certification," prior to signing the Acquisition Decision Memorandum (ADM). This certification memorandum shall be prepared "for the record," and shall include the statements in the attachment, without modification. If the program is initiated at a later decision point, e.g., Milestone C, a similar memorandum shall be prepared, as a matter of policy, consistent with the intent of the statute. The certification memorandum shall be submitted to the congressional defense committees, as defined at 10 U. S.C. 101_(16), with the first Selected Acquisition Report for the program after completion of the certification.

The MDA may waive one or more of components (1) through (6) of the required certification (specifically, one or more of paragraphs (1) through (6) in the attachment) for an MDAP if the MDA determines that, but for such a waiver, the Department would be unable to meet critical national security objectives. The MBA shall submit the waiver, the determination, and reasons for the determination, in writing, to the congressional defense committees within 30 days of authorizing the waiver. The MDA may not delegate this waiver authority.

In addition to the certification memorandum, the MDA will include the following statement in the ADM: "I have reviewed the program and have made the certifications required, or executed a waiver as authorized, by section 2366a of title 10, United States Code."

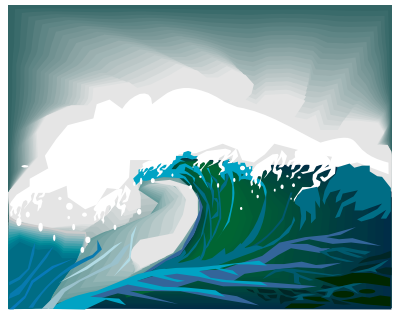
This policy shall apply to MDAPs approved by me and to MDAPs managed by Department of Defense Component Acquisition Executives or the Assistant Secretary of Defense for Networks and Information Integration. This requirement went into effect January 6, 2006, and shall be reflected in the next revision to Department of Defense Instruction 5000.2.

Attachment:
As stated

Certification Submitted with the First Selected Acquisition Report for the Program

• • • But Waivers Are Allowed

(c) WAIVER FOR NATIONAL SECURITY. The milestone decision authority may waive the applicability to a major defense acquisition program of one or more components (as specified in paragraph (1), (2), (3), (4), (5), (6), (7), (8), or (9) of subsection (a)) of the certification requirement if the milestone decision authority determines that, but for such a waiver, the Department would be unable to meet critical national security objectives. Whenever the milestone decision authority makes such a determination and authorizes such a waiver, the waiver, the determination, and the reasons for the determination shall be submitted in writing to the congressional defense committees within 30 days after the waiver is authorized.



Changes Made to Meet the Statutory Requirements

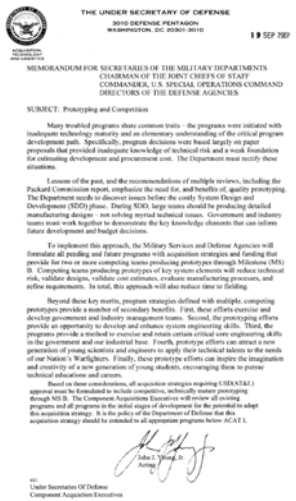
- **USD(AT&L) practice**
  - **Programs will no longer be initiated with immature technologies**
  - **The same standards apply to all acquisition programs**
- **DDR&E will provide technical advice to the MDA in support of certification**
  - **For MDAPs, MAIS, and space systems**
  - **Approved TRA process and report will be the basis of that advice**

Draft New 5000.2 Language
September 13, 2007

- **For the SDD Phase:**

3.6.7.1 "Final Requests for Proposals (RFPs) for the SDD phase shall not be released, nor shall any action be taken that would commit the program to a particular contracting strategy for SDD, until the MDA has approved the Acquisition Strategy. The PM shall include language in the RFP advising offerors that (1) the government will not award a contract to an offeror whose proposal is based on technologies that have not been demonstrated in a relevant environment, and (2) that offerors will be required to specify the technology readiness level of the key technologies on which their proposal is based and to provide reports documenting how those technologies have been demonstrated in a relevant environment."

Prototyping and Competition Policy Promotes Technology Maturity



THE UNDER SECRETARY OF DEFENSE
3010 DEFENSE PENTAGON
WASHINGTON, DC 20301-3010

19 SEP 1997

MEMORANDUM FOR SECRETARIES OF THE MILITARY DEPARTMENTS
CHAIRMAN OF THE JOINT CHIEFS OF STAFF
COMMANDER, U.S. SPECIAL OPERATIONS COMMAND
DIRECTORS OF THE DEFENSE AGENCIES

SUBJECT: Prototyping and Competition

Many troubled programs share common traits – the programs were initiated with inadequate technology maturity and an elementary understanding of the critical program development path. Specifically, program decisions were based largely on paper proposals that provided inadequate knowledge of technical risk and a weak foundation for estimating development and procurement cost. The Department must rectify these situations.

Lessons of the past, and the recommendations of multiple reviews, including the Packard Commission report, emphasize the need for, and benefits of, quality prototyping. The Department needs to discover issues before the costly System Design and Development (SDD) phase. During SDD, large teams should be producing detailed manufacturing designs – not solving myriad technical issues. Government and industry teams must work together to demonstrate the key knowledge elements that can inform future development and budget decisions.

To implement this approach, the Military Services and Defense Agencies will formulate all pending and future programs with acquisition strategies and funding that provide for two or more competing teams producing prototypes through Milestone (MS) B. Competing teams producing prototypes of key system elements will reduce technical risk, validate designs, validate cost estimates, evaluate manufacturing processes, and refine requirements. In total, this approach will also reduce time to fielding.

Beyond these key merits, program strategies defined with multiple, competing prototypes provide a number of secondary benefits. First, these efforts exercise and develop government and industry management teams. Second, the prototyping efforts provide an opportunity to develop and enhance system engineering skills. Third, the programs provide a method to exercise and retain certain critical core engineering skills in the government and our industrial base. Fourth, prototype efforts can attract a new generation of young scientists and engineers to apply their technical talents to the needs of our Nation's Warfighters. Finally, these prototype efforts can inspire the imagination and creativity of a new generation of young students, encouraging them to pursue technical educations and careers.

Based on these considerations, all acquisition strategies requiring USD(A&T) approval must be formulated to include competitive, technically mature prototyping through MS B. The Component Acquisitions Executives will review all existing programs and all programs in the initial stages of development for the potential to adopt this acquisition strategy. It is the policy of the Department of Defense that this acquisition strategy should be extended to all appropriate programs below ACAT I.

John J. Young, Jr.
Acting

cc:
Under Secretaries Of Defense
Component Acquisition Executives

- **Policy**
  - **During SDD, large teams should be producing detailed manufacturing designs – not solving myriad technical issues**
  - **All pending and future programs formulate acquisition strategies and provide funding for two or more competing teams to produce prototypes of key system elements through Milestone B**
- **Promotes maturity via**
  - **More rigorous relevant environment demonstrations**
  - **More comprehensive evidence of maturity**
  - **Fewer technical problems in the final design**
  - **Using prototypes for accelerated life-cycle tests**
  - **Providing insight into production issues**

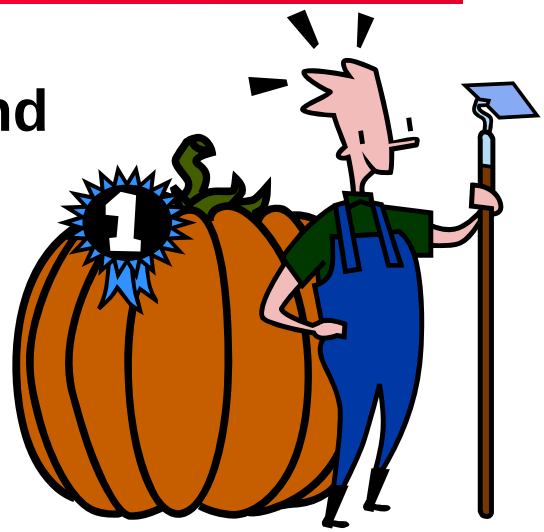
Desired Outcomes from Process Changes in Support of the New Situation

- **Safeguards in place to provide the DDR&E with the confidence necessary to assure the MDA that certification can be made**
  - **To make the TRA support the certification, it must draw upon the best technical information available *prior to source selection***
- **Assurance that technologies have been demonstrated in a relevant environment by the winning SDD Phase contractor**
  - **To initiate programs with mature technologies, the source selection process should include a focus on technical maturity**
- **ADM language establishing conditions for CTE insertion after Milestone B**
  - **To initiate programs with mature technologies, immature CTEs may be pursued in a parallel development effort, if approved maturation plans submitted with the TRA— *on ramp vice off ramp for preferred approaches with undemonstrated technologies***

Processes and Best Practices Must Change to Achieve These Outcomes (1 of 2)

- **10 USC 2366a is new, so technically what follows are to some extent *best ideas* vice *best practices***
  - **Nevertheless, many of the changes to increase rigor in the process are indeed best practices**
  - **The new practices and processes are subject to change as more experience is gained**
- **All practices and processes presented herein are not official until captured in the TRA Deskbook**

Processes and Best Practices Must Change to Achieve These Outcomes (2 of 2)



- Increasing the rigor of the TRA process and report to assure a quality product
  - Initiating the TRA process
  - Identifying CTEs
  - Assessing CTE maturity
  - Preparing the TRA report
- Including a focus on technical maturity in source selection to assure mature technologies in programs
  - Preparing the RFP
  - Assessing CTE maturity during source selection
- Using the ADM to pursue technology maturation and insertion after Milestone B
  - Preparing maturation plans for CTEs the PM would like to insert
  - Drafting ADM language

Best Practices for Initiating the TRA Process (1 of 2)

No change to current Deskbook

- ***Keep the Component S&T Executive and the DUSD(S&T) informed throughout the entire TRA process***

No change to current Deskbook

- **Begin the TRA process 12-14 months prior to the anticipated Milestone/KDP B for an ACAT ID or IAM program**
  - **Component should immediately prepare a schedule**
  - **Align with the Acquisition Strategy**
  - **Incorporate into IMS**
  - **DUSD(S&T) should provide comments on the schedule and indicate conditions for agreement**

Best Practices for Initiating the TRA Process (2 of 2)

Adds rigor to current Deskbook

- **Establish an Independent Panel of subject matter experts to identify candidate CTEs and assess CTE maturity**
  - ***Must be genuine subject matter experts in relevant disciplines***
  - ***Must be independent of program to be credible***
  - **Coordinate with DUSD (S&T) who should provide comments and indicate conditions for agreement**

Best Practices for Identifying CTEs

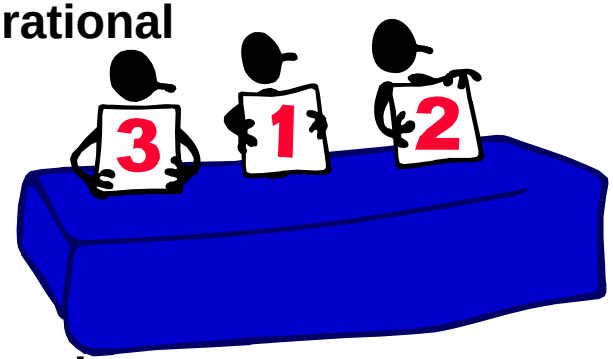
Change to current Deskbook; shifts responsibility from the PM to the Panel

- **Use the Independent Panel of subject matter experts to identify CTE candidates in conjunction with the program; final list should reflect DUSD(S&T) recommended changes**
  - **Most current system design should be the starting point for**
  - **Any system/component may be a CTE until proven otherwise**
  - **Determination is based on system design, WBS, or architecture provided by the program**
  - **PM should prepare an initial list of CTE candidates**
    - **Based on information from BAAs, RFIs, and literature searches along with actual results from program-funded efforts in government laboratories or industry when there will be a full and open competition with a formal source selection process**
    - **Based on planned technical approaches (e.g., actual design when available otherwise use government's reference architecture) when sole source or competitive down select**
  - **Final CTE list established during coordination; DUSD(S&T) may recommend changes**
    - **Additions may include any technologies that warrant the rigor of the formal TRA process**

Best Practices for Assessing CTE Maturity

Adds rigor to current Deskbook

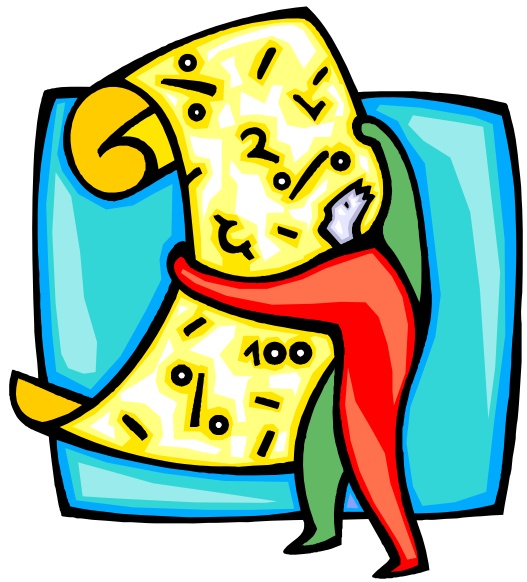
- **Use the Independent Panel to assess CTE maturity; base all conclusions on objective evidence and the technical expertise of the Panel**
  - **Use the requirements, identified capabilities, system architecture, and the concept of operations and/or the concept of employment to define relevant and operational environments**
  - **Form subteams (on the basis of subject matter expertise) to deliberate on the appropriate TRL and then defend their position to the entire Panel**
  - **Do not constrain the assessment process to be a response to a "program-developed" position on the TRL**



Best Practices for Preparing the TRA Report

Adds rigor to current Deskbook

- **The TRA report should consist of (1) a short description of the program (2) the Independent Panel credentials (3) Independent Panel findings and supporting evidence (4) other technical information deemed pertinent by the Component S&T Executive and (5) a cover letter signed by the Component S&T Executive**
  - **The Independent Panel (Chair) should prepare the following:**
    - **Panel deliberations, findings, and conclusions**
    - **Evidence and rationale for the final assessment in a way that the chain of logic is clear**
      - **Reference specific sources using actual pages in reports for the evidence presented**
  - **A PM's self assessment of TRLs may be included in the cover letter**
  - **The Component S&T Executive should indicate agreements or disagreements with the findings of the Independent Panel in the cover letter**



Best Practices for Preparing the RFP

Change to current Deskbook

- **Include language in the RFP to convey DoD's desire to have technologies demonstrated in a relevant environment by the winning SDD Phase contractor**
  - **A description of the relevant environment and the candidate CTEs**
  - **Based upon the definitions and guidance provided in the TRA Deskbook, offerors must identify all CTEs in their proposal, provide the rationale for classifying them and as CTEs, assess their TRL, and include sufficient technical evidence to support the TRL assessment**
  - **A description of how the CTEs and the associated evidence of maturity will be evaluated**

Other

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References and Resources

- **Defense Acquisition Resource Center http://akss.dau.mil/darc/darc.html**
  - **DoD Directive 5000.1 (DoDD 5000.1), *The Defense Acquisition System*, dated May 12, 2003**
  - **DoD Instruction 5000.2 (DoDI 5000.2), *Operation of the Defense Acquisition System*, dated May 12, 2003**
  - ***Defense Acquisition Guidebook***
- ***DAU Continuous Learning Module CLE021***
  - **https://learn.dau.mil/html/clc/Clc.jsp to browse it**
- ***TRA Deskbook***
  - **http://www.defenselink.mil/ddre/doc/tra_deskbook_2005.pdf**
- **DDR&E**
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